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Gilder

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(54) **"GO HOME" FEATURE FOR ROAMING APPLICATIONS**

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G06F 9/48	(2006.01)

(52) **U.S. Cl.**

CPC ***H04L 67/10*** (2013.01); ***G06F 9/4862*** (2013.01)

(58) **Field of Classification Search**

CPC H04L 67/04; H04L 67/2823; H04L 67/10; H04L 67/125; H04L 67/34; G06F 21/10

See application file for complete search history.

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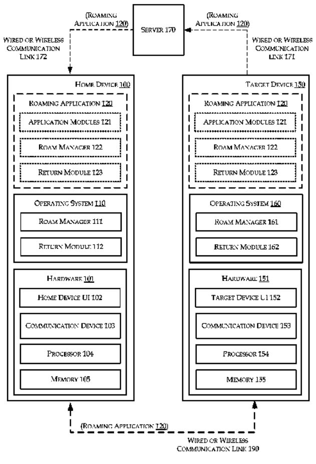
(57) **ABSTRACT**

Techniques related to a "go home" feature for a roaming application are generally described where a roaming application can automatically return from a target device to a home device. The home device can manage an execution environment for the roaming application on behalf of an owner of the roaming application. The roaming application may roam from the home device to a target device, execute on the target device, and automatically return from the target device to the home device, in response to a return event. The roaming application implementing the "go home" feature may be indifferent to specific User Interface (UI) features of target devices, allowing roaming applications to access a wider diversity of potential target devices, and also allowing simplification/omission of target device UI.

16 Claims, 7 Drawing Sheets



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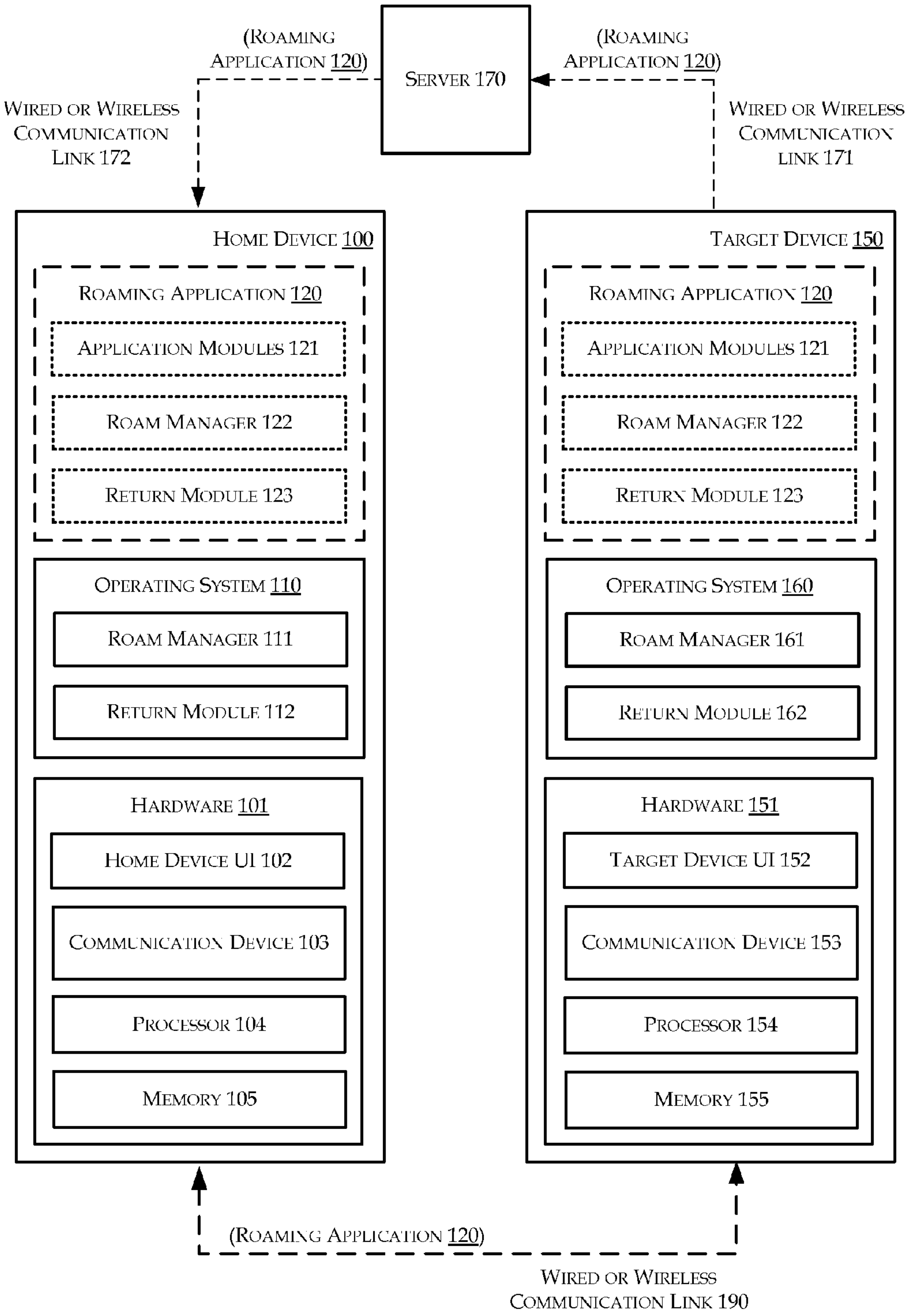
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Server 170
(Roaming Application 120)
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Home Device 100
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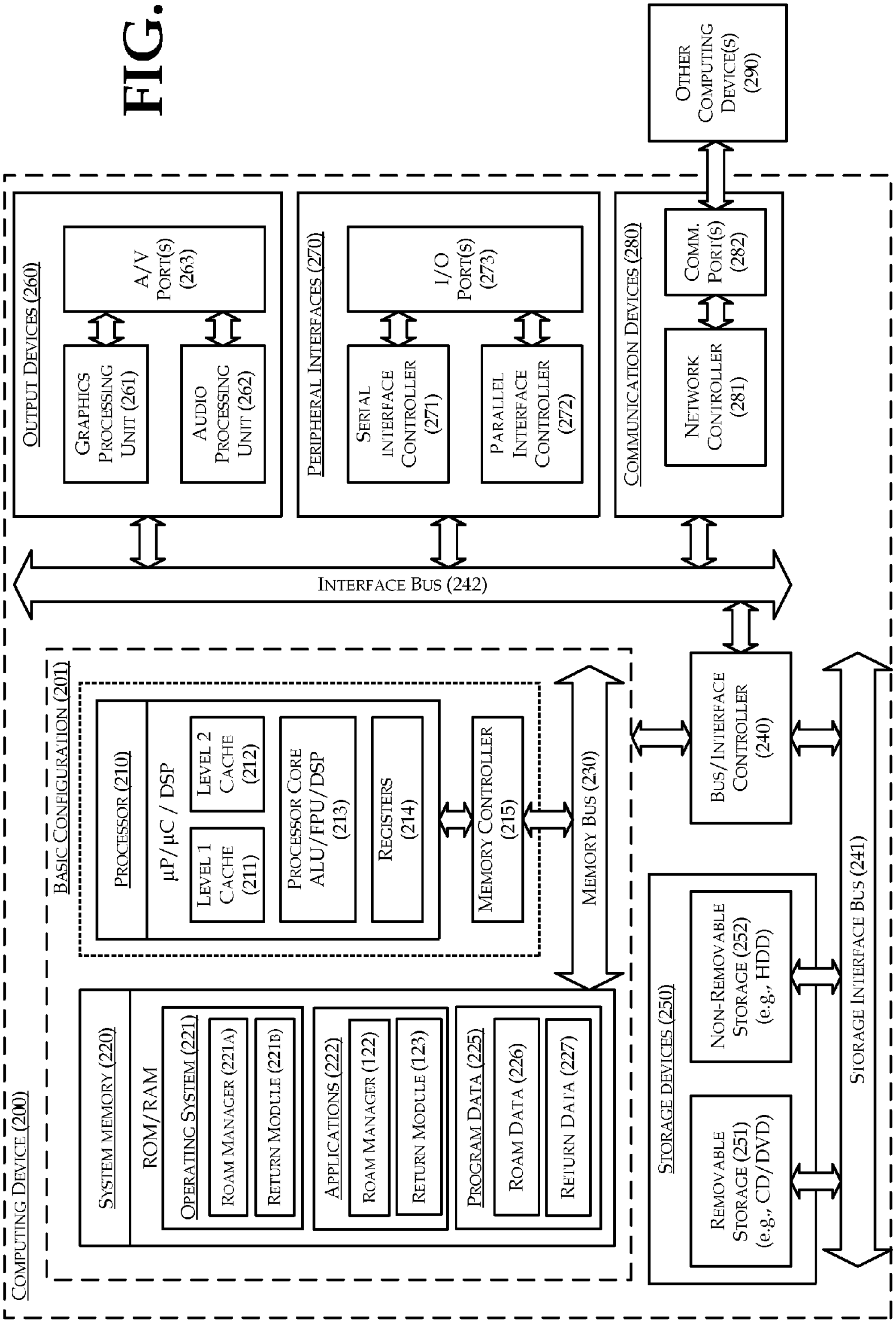
Application Modules 121
Roam Manager 122
Return Module 123
Operating System 110
Roam Manager 111
Return Module 112
Hardware 101
Home Device UI 102
Communication Device 103
Processor 104
Memory 105
Target Device 150
Roaming Application 120
Application Modules 121
Roam Manager 122
Return Module 123
Operating System 160
Roam Manager 161
Return Module 162
Hardware 151
Target Device UI 152
Communication Device 153
Processor 154
Memory 155
(Roaming Application 120)
Wired or Wireless Communication Link 190

FIG. 1

FIG. 2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Basic Configuration (201)
Processor (210)
µP/µC / DSP
Level 1 Cache (211)
Level 2 Cache (212)
Processor Core ALU/FPU/DSP (213)
Registers (214)
Memory Controller (215)
Memory Bus (230)
System memory (220)
ROM/RAM
Operating System (221)
Roam Manager (221a)
Return Module (221b)
Applications (222)
Roam Manager (122)
Return Module (123)
Program Data (225)
Roam Data (226)
Return Data (227)
Bus/Interface Controller (240)
Interface Bus (242)
Storage devices (250)
Removable Storage (251) (e.g., CD/DVD)
Non-Removable Storage (252) (e.g., HDD)
Storage Interface Bus (241)
Output Devices (260)
Graphics Processing Unit (261)
Audio Processing Unit (262)
A/V Port(s) (263)
Peripheral Interfaces (270)
Serial interface Controller (271)
Parallel Interface Controller (272)
I/O Port(s) (273)
Communication Devices (280)
Network Controller (281)
Comm. Port(s) (282)
Other Computing Device(s) (290)

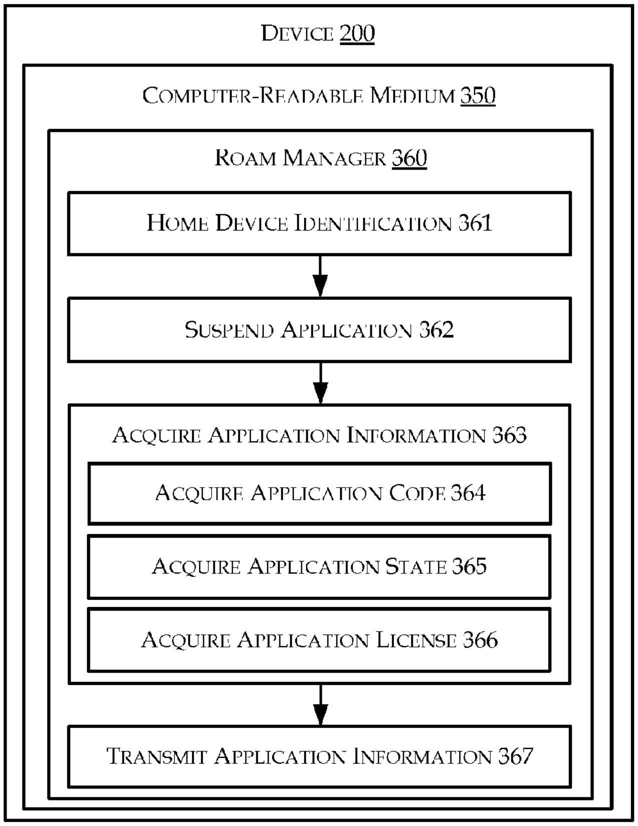
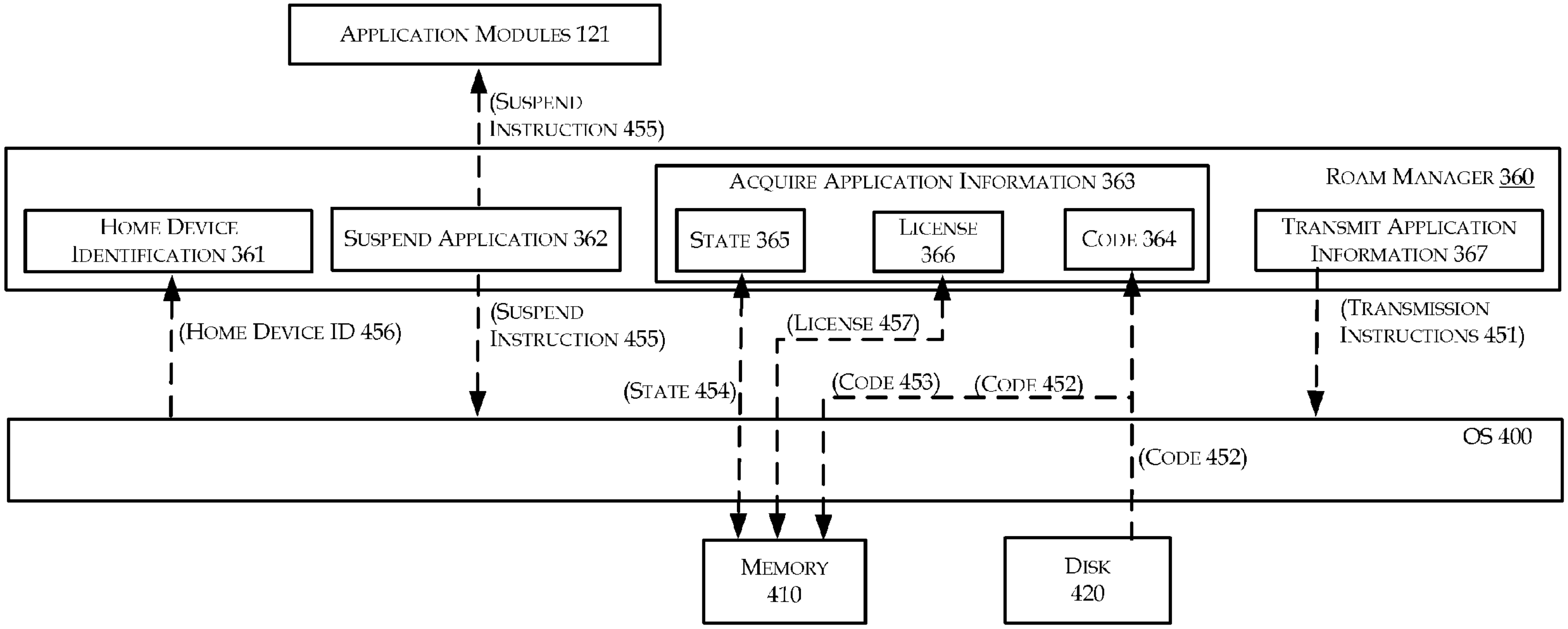

DEVICE 200
COMPUTER-READABLE MEDIUM 350
ROAM MANAGER 360
HOME DEVICE IDENTIFICATION 361
SUSPEND APPLICATION 362
ACQUIRE APPLICATION INFORMATION 363
ACQUIRE APPLICATION CODE 364
ACQUIRE APPLICATION STATE 365
ACQUIRE APPLICATION LICENSE 366
TRANSMIT APPLICATION INFORMATION 367

FIG. 3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(SUSPEND INSTRUCTION 455)
ROAM MANAGER 360
ACQUIRE APPLICATION INFORMATION 363
HOME DEVICE IDENTIFICATION 361
SUSPEND APPLICATION 362
STATE 365
LICENSE 366
CODE 364
TRANSMIT APPLICATION INFORMATION 367
(HOME DEVICE ID 456)
(SUSPEND INSTRUCTION 455)
(LICENSE 457)
(TRANSMISSION INSTRUCTIONS 451)
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(CODE 453)
(CODE 452)
OS 400
(CODE 452)
MEMORY 410
DISK 420

FIG. 4

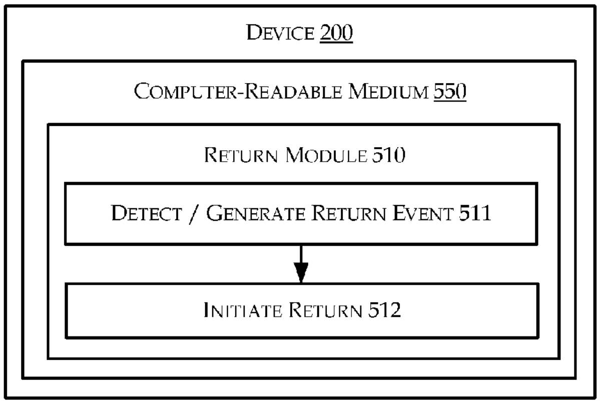
DEVICE 200
COMPUTER-READABLE MEDIUM 550
RETURN MODULE 510
DETECT / GENERATE RETURN EVENT 511
INITIATE RETURN 512

FIG. 5

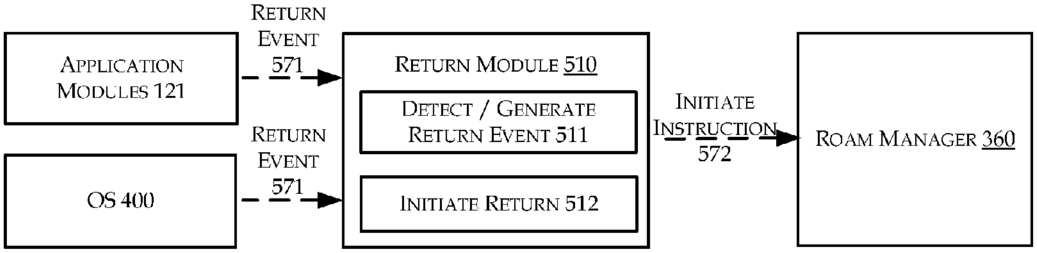
APPLICATION MODULES 121
OS 400
RETURN EVENT 571
RETURN EVENT 571
RETURN MODULE 510
DETECT / GENERATE RETURN EVENT 511
INITIATE RETURN 512
INITIATE INSTRUCTION 572
ROAM MANAGER 360

FIG. 6

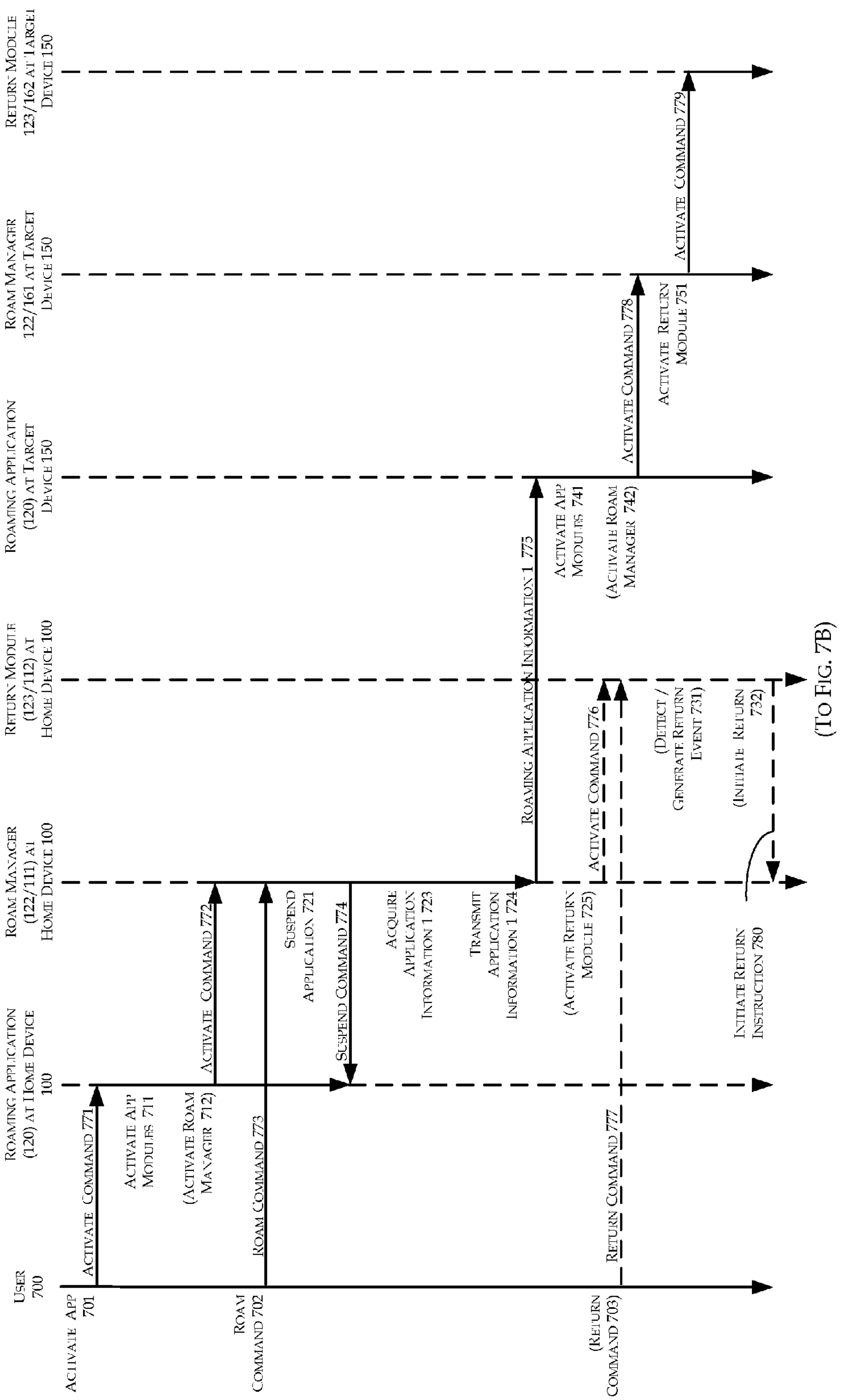
User 700
Roaming Application (120) at Home Device 100
Roam Manager (122/111) at Home Device 100
Return Module (123/112) at Home Device 100
Roaming Application (120) at Target Device 150
Roam Manager 122/161 at Target Device 150
Return Module 123/162 at Target Device 150
Activate App 701
Activate Command 771
Activate App Modules 711
(Activate Roam Manager 712)
Activate Command 772
Roam Command 702
Roam Command 773
Suspend Application 721
Suspend Command 774
Acquire Application Information 1 723
Transmit Application Information 1 724
Roaming Application Information 1 775
Activate App Modules 741
(Activate Roam Manager 742)
Activate Command 778
Activate Return Module 751
Activate Command 779
(Activate Return Module 725)
Activate Command 776
(Return Command 703)
Return Command 777
(Detect / Generate Return Event 731)
(Initiate Return 732)
Initiate Return Instruction 780
(To Fig. 7B)

FIG. 7A

(From Fig. 7A)

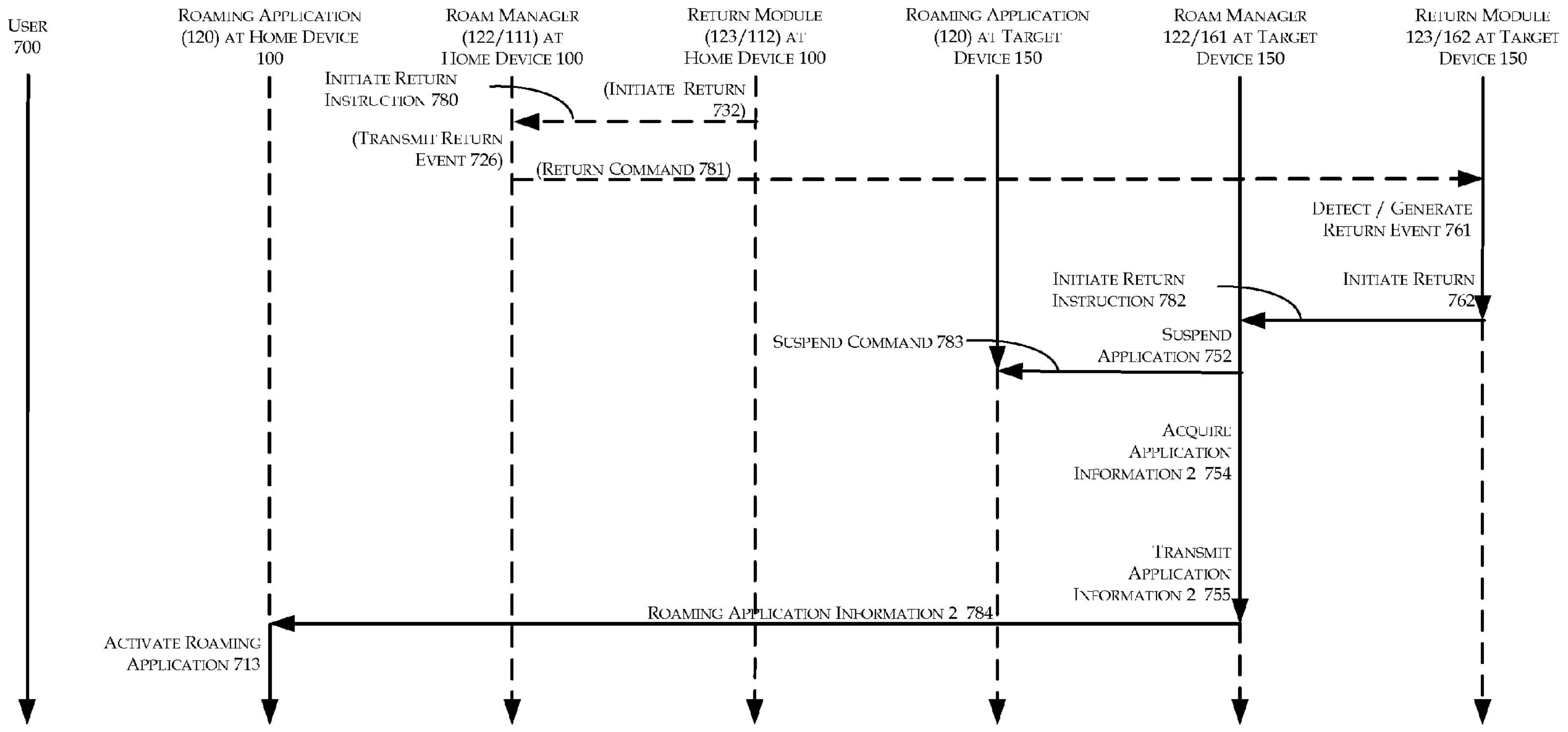
User 700
Roaming Application (120) at Home Device 100
Roam Manager (122/111) at Home Device 100
Return Module (123/112) at Home Device 100
Roaming Application (120) at Target Device 150
Roam Manager 122/161 at Target Device 150
Return Module 123/162 at Target Device 150
Initiate Return Instruction 780
(Initiate Return 732)
(Transmit Return Event 726)
(Return Command 781)
Detect / Generate Return Event 761
Initiate Return Instruction 782
Initiate Return 762
Suspend Command 783
Suspend Application 752
Acquire Application Information 2 754
Transmit Application Information 2 755
Roaming Application Information 2 784
Activate Roaming Application 713

FIG. 7B

"GO HOME" FEATURE FOR ROAMING APPLICATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS APPLICATION

This is a U.S. National Stage Application filing under 35U.S.C. §371of International Application PCT/US11/30344, entitled "GO HOME" FEATURE FOR ROAMING APPLICATIONS, filed on Mar. 29, 2011, which is incorporated by reference herein in its entirety.

BACKGROUND

Unless otherwise indicated herein, the materials described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

Many objects today have embedded computer processors, and in the future, this trend is expected to continue and accelerate. Devices will be increasingly ubiquitous, increasingly powerful, and increasingly interconnected and capable of communicating with each other. While there are many potential benefits of environments in which we are surrounded by powerful, interconnected devices, many technical challenges remain. Allowing users to constructively interact with and control the various devices in their environment presents technical challenges. Similarly, allowing software applications to roam between, interact with and control multiple devices presents technical challenges for the electronics and software industries.

SUMMARY

The present disclosure describes methods, devices and computer readable media relating to a "go home" feature for roaming applications. Some example computer readable media may comprise computer executable instructions configured to automatically initiate a return of a roaming application from a target device to a home device. The home device provides an execution environment for the roaming application on behalf of an owner of the roaming application, and the roaming application may temporarily roam to a target device and return to the home device. The instructions may implement roaming application modules configured to execute on the home device, to roam from the home device to a target device, to execute on the target device, and to return from the target device to the home device. The instructions may furthermore implement modules configured to automatically initiate the return of the roaming application from the target device to the home device in response to a return event. The return event may comprise, for example, a timer reaching a designated value, completion of a designated task, a return signal from the home device, and/or a failure in the target device. An additional module may be configured to override the return of the roaming application from the target device to the home device, in response to a user command. Also, a module may be configured to automatically initiate a roam by the roaming application from the target device to a server, in response to a failure to return to the home device.

Some example devices may comprise home devices configured to provide an execution environment for a roaming application on behalf of an owner of the roaming application. Such a device may include a processor, a memory, and an operating system loadable into the memory and configured to execute on the processor. The operating system may be configured to provide an execution environment for the roaming application as it executes at the home device, as well as to transfer the roaming application from the home device to a target device, for example, in response to user command received at the home device. The operating system may also be configured to initiate return of the roaming application from the target device to the home device, for example by sending a communication to the target device in response to a return event. In this scenario the return event may comprise, for example, a user command, a timer reaching a designated value, and/or an interruption or degradation of signal quality on a communication channel used by the home device to communicate with the target device, e.g., due to a wireless range between the home device and the target device. The operating system may also comprise instructions to retrieve the roaming application from a server, in response to a failure of the roaming application to return to the home device.

Some example devices may comprise target devices configured to provide an execution environment for a roaming application, and configured to return the roaming application to a home device associated with an owner of the roaming application. Such a device may include a processor, a memory, and operating system loadable into the memory and configured to execute on the processor. The operating system may be configured to provide an execution environment for the roaming application as it executes at the target device, as well as transfer the roaming application from the target device to the home device. The operating system may also be configured to initiate return of the roaming application from the target device to the home device in response to a return event. In this scenario the return event may comprise, for example, an automatically initiated return command from the roaming application, a timer reaching a designated value, an interruption or degradation of signal quality on a communication channel used by the home device to communicate with the target device, a completion of a designated task, a return signal from the home device, and/or a failure in the target device. The operating system may also comprise instructions to automatically transfer the roaming application from the target device to a server, in response to a failure to return the roaming application to the home device.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings, in which:

FIG. **1** is a diagram illustrating an example home device, target device, server, and roaming application;

FIG. **2** is a block diagram illustrating a computing device as one example of a home and/or target device;

FIG. **3** is a block diagram illustrating an example roam manager;

FIG. **4** is a schematic diagram illustrating example operations of a roam manager;

FIG. **5** is a block diagram illustrating an example return module;

FIG. **6** is a schematic diagram illustrating example operations of a return module; and

FIG. **7**, including FIG. **7**A and FIG. **7**B, is a diagram illustrating example operations and interactions of a user, roaming application, roam manager(s), and return module(s) as they interact with a home device and target device, all arranged in accordance with at least some embodiments of the present disclosure.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, may be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and made part of this disclosure.

The present disclosure is generally drawn, inter alia, to methods, devices, and/or computer readable media related to a "go home" feature for roaming applications. The "go home" feature may allow a roaming application to automatically return from a target device to a home device. The home device provides an execution environment for the roaming application on behalf of an owner of the roaming application. The roaming application may roam from the home device to a target device, execute on the target device, and automatically return from the target device to the home device, in response to a return event. A roaming application implementing the "go home" feature need not be encumbered by a lack of adequate User Interface (UI) features of target devices, allowing roaming applications to access a wider diversity of potential target devices, and also allowing simplification/omission of target device UI.

FIG. **1** is a diagram illustrating an example home device, target device, server, and roaming application, in accordance with at least some embodiments of the present disclosure. Home device **100** may comprise hardware **101** and operating system **110**. Hardware **101** may comprise home device UI **102**, communication device **103**, processor **104** and memory **105**. Home device operating system **110** may comprise roam manager **111** and return module **112**. Target device **150** may comprise hardware **151** and operating system **160**. Hardware **151** may comprise target device UI **152**, communication device **153**, processor **154** and memory **155**. Target device operating system **160** may comprise roam manager **161** and return module **162**. Roaming application **120** may comprise application module(s) **121**, roam manager **122**, and return module **123**. The roaming application **120** is illustrated using dashed lines within home device **100** as well as within target device **150**, to indicate that the roaming application **120** may be configured to execute at the home device **100**, e.g., prior to roaming to the target device **150**, and may be configured to execute at the target device **150**, e.g., prior to returning to the home device **100**.

In FIG. **1**, home device **100** may be configured to communicate with target device **150** via wired or wireless communication link **190**, allowing the roaming application **120** to roam from the home device **100** to the target device **150**, and to subsequently return to the home device **100**. Target device **150** may be configured to communicate with server **170** via wired or wireless communication link **171**, allowing the roaming application **120** and/or roaming application data to be transmitted from the target device **150** to the server **170**. Home device **100** may be configured to communicate with server **170** via wired or wireless communication link **172**, allowing the roaming application **120** and/or roaming application data to be transmitted from the server **170** to the home device **100**, as described in greater detail herein.

In FIG. **1**, the roaming application **120** may be adapted to execute on the home device **100**. Upon the occurrence of a roam initiating event, e.g., a user entering a roam command via the home device UI **102**, the roaming application **120** may roam to the target device **150**, and may continue executing at the target device **150**. Depending on the specific embodiment, the roam operation may be carried out by one or more of the roam managers **122**, **111**, **161**, and/or some combination thereof. Upon the occurrence of a return event, e.g., a timer reaching a predetermined value, one or more of the return modules **123**, **112**, **162**, and/or some combination thereof may be adapted to automatically initiate a return of the roaming application **120** to the home device **100**. As with the initial roam to the target device **150**, depending on the specific embodiment, the return operation may be carried out by one or more of the roam managers **122**, **111**, **161**, and/or some combination thereof. Upon successful return, the roaming application **120** may continue executing on the home device **100**.

In some embodiments, roam managers **122**, **111**, and/or **161** may be configured to return the roaming application **120**, or some roaming application data, to the server **170** in the event that the roam managers **122**, **111**, and/or **161** are unable to return the roaming application **120** to the home device **100**. The home device **100** may connect to the server **170** and retrieve the roaming application **120** or associated data, in lieu of recovering the roaming application **120** from the target device **150**.

With regard to a "go home" feature for roaming applications in general, "roaming" applications may roam from device to device, optionally allowing users to interact with an application via different devices in the field, and optionally allowing applications to control devices in a user's environment according to user and/or application specifications and commands.

In some embodiments, roaming applications may be adapted to take advantage of so-called Ubiquitous Computing (UBICOMP) environments, through their ability to roam among different execution environments, even during the lifetime of the application's execution. For example, a user of a handheld device running a roaming application that analyzes product inventory might walk through a shop floor, and come across another computing device coupled to a larger display that is more appropriate for viewing charts and graphs. The user may interact with a UI on the handheld device to cause the roaming application to roam to the device with the larger display. The user may view and interact with the roaming application as it executes in the execution environment provided by the device coupled to the larger display. The user may then interact with a UI on the handheld device to retrieve the roaming application to the handheld device and continue walking through the shop.

In some UBICOMP environments, applications may be adapted to run in a heterogeneous environment including, for example, different display sizes and types, different input devices and sensors, and different machine architectures. Such resources may be automatically discovered by the roaming application during its execution, and the application and/

or operating systems of devices that host the roaming application may determine how and when to best use these resources, and how to migrate the application from one environment to the next.

When a roaming application roams from one device to another, e.g., from a smart phone home device to a tabletop display target device, the target device may or may not have adequate UI capabilities to allow the user to interact with the roaming application via target device UI. When a target device does not have adequate UI to allow the user to interact with the roaming application via target device UI, and if the roaming application does not include a "go home" feature as described herein, the user may be unable to command the roaming application to return to the home device. The user may instead restart the roaming application on his or her home device, losing any state changes that occurred and/or data that was collected during roam to the target device.

In some embodiments, a roaming application can be configured to automatically attempt to "go home" to a home device, such as a smart phone or laptop that is registered as a home device for the roaming application. When roaming from the home device, the roaming application may for example be permitted to spend some predetermined interval at a target device, after which the roaming application may attempt to go home. A variety of configuration options are possible. A roaming application may be configured to automatically attempt to go home after a preset time interval has expired, after completion of a task, and/or in response to an alternate channel instruction to go home. An alternate channel instruction to go home may comprise, for example, an instruction that is received at the target device via a channel other than target device UI, such as a return command from the home device as described herein. The roaming application may be configured to temporarily roam to a server and continue executing in the execution environment provided by the server, and/or save application information and/or other data to a server, without executing on the server, if the roaming application cannot go directly back to the home device. Saving application information to a server may include, for example, generating acquiring application information as described in connection FIG. **3**, block **363**, and transmitting one or more application information files to the server.

In some embodiments, a roaming application may be configured to register a Global Unique Identifier (GUID), an IP address, or some other identifier of a home device, allowing the roaming application to identify and return to its registered home device. Upon roaming away from the home device, the roaming application may be configured to start a roam session timer. When the timer reaches some predetermined value (the specific predetermined value may depend on the nature of the application), the roaming application may be configured to display a popup UI on the display of the target device that says, for example, "Select OK to continue Roaming Session. The application will go home automatically in [60] seconds." If the user selects "OK" then the roaming application may be configured to reset the roam session timer. If the user selects another UI button such as a "Go Home Now" button, then the roaming application may be configured to attempt to return to the home device immediately, identified by the GUID, registered IP address, and/or other identifier of the home device. If desirable, a "Turn Off Roam Session Timer" button may also be provided in the popup UI, to disable the roam session timer for the duration of the roam session. In some embodiments, e.g., for roaming applications that are designed specifically for one or more tasks, a roaming application may be configured to display a popup UI at the target device, upon completion of a task at the target device, similar to the above described UI that may be displayed when the timer reaches a predetermined value.

In some embodiments, which may be implemented alongside the timer/task completion-type embodiments described above, a roaming application may be configured to respond to an alternate channel instruction to go home. An alternate channel instruction may comprise an instruction received from a device other than the target device on which the roaming application is presently executing. This is referred to as an "alternate channel instruction" because it is a channel for interacting with a roaming application other than through a target device UI. The target device UI, when adequate to support interacting with a roaming application, may provide a primary channel for interacting with a roaming application as it executes on the target device. In one example, the home device may be configured to remotely (either wired or wirelessly) send an alternate channel instruction to the roaming application, instructing the roaming application to go home.

The alternate channel instruction may be implemented using a same communication link as that used to initially transfer the roaming application to the target device. For example, in a scenario in which an application roams via a wireless communication link to a target device, a same wireless communication link may be used for a subsequent "go home" instruction. Instructions may be transmitted using any of a number of protocols which are currently available, or as may be developed in the future. For example, a variety of application layer protocols, transport layer protocols, internet layer protocols, and link layer protocols are commonly used for communications between devices, any of which may be leveraged as appropriate for specific embodiments.

The target device may be configured to include a feature for transmitting alternate channel communications from the home device to the roaming application and/or target device operating system. Upon receiving an instruction to go home, the target device may be configured to initiate return of the roaming application and/or to forward the instruction to the roaming application, and the roaming application may in turn be configured to initiate its return to the home device.

When a communication link to a home device is lost, so that the roaming application cannot go directly back to the home device, the roaming application may be configured to temporarily roam to a known server location, from which it may be configured to return to the home device at such time as the home device links to the server. As an alternative to "roaming" to the server and then back to the home device while continuing to execute, the roaming application may be configured to save application information and/or other application data to the server, and shut itself down at the target device. Saving application information to a server may include, for example, generating an application information file as described in connection FIG. **3**, block **363**, and transmitting the application information file to the server. Similarly, in various configurations described herein, transferring application information may be employed as an alternative to roaming back to a home device and continuing to execute at the home device.

A variety of example uses for this technology might be suggested. In a business setting, a person giving a presentation might instruct the presentation application, through a UI, to roam to a large display so that others can view the presentation. The presenter may not have access to the display UI for causing the presentation application to return the home device, or to roam to a different display. The technology described herein may be used to cause the presentation application to return to a home device and/or to another target device. In a social/entertainment setting, a roaming application may provide a virtual pet that the owner can bring to gathering places, e.g., on a smart phone. The virtual pet may roam among a variety of devices at the social gathering, and the owner may not have access to, or may not know which devices the virtual pet has roamed to. The technology described herein may be used to cause the virtual pet application to return to a home device and/or to roam to another target device.

The disclosed technology also may have implications related to software licensing. For example, some roaming application developers may be concerned that if their application is permitted to roam, and the application is simultaneously re-started on a home device, multiple instances of the application could be used in violation of the application's terms of use. However, applications can be adapted in accordance with various techniques described herein such that the applications will not roam indefinitely and instead are required to "go home" after the completion of a task, expiration of a predetermined time interval or upon the occurrence of some other return event. If an application cannot go home, it can be configured to nonetheless shut itself down at the target device and/or go to a temporary server location, and optionally to self-destruct at the target device, so that the roaming application and/or roaming application information cannot be re-accessed from the target device.

Furthermore, the technology described herein may be utilized to enable roaming applications to roam to a wider number of devices than would otherwise be possible. As a wide variety of objects and devices incorporate increasing processing power, these objects and devices become potential target devices, capable of hosting roaming applications. However, while a wristwatch, camera, coffee maker, or other potential target device may be available to execute roaming applications, such device may include minimal to no user interface features to support user interaction with a roaming application after the application roams to the target device. By leveraging the technology disclosed herein, the need for target device UI features may be reduced or eliminated and the variety of target devices to which applications can roam increases. Conversely, as roaming applications proliferate, the described technology may create a broader range of options for device developers in terms of how to configure devices. The cost of developing UI features can be omitted for some devices, while device capabilities of otherwise executing roaming applications may be included.

In some examples, users of roaming applications may be concerned with security associated with data and other information that can potentially be compromised by allowing their applications to roam to target devices. The described technology may include a feature whereby, in the event that a user cannot control a roaming application from a target device, the user may nonetheless recover the roaming application. Furthermore, in some embodiments, roaming applications may be configured to "self destruct" or clean up roaming application code and data at the target device prior to returning to the home device. A roaming application may be configured to delete, scramble, or otherwise destroy roaming application code and data existing at the target device as a final step in roaming from the target device.

Returning to FIG. **1**, in some embodiments, the roaming application **120** may include a roam manager **122** and return module **123** controlling roam and return of the application **120** to and from the home device **100**. In embodiments wherein the roaming application **120** itself controls roam and return of the application **120**, the home device **100** and target device **150** may or may not also include roam managers **111**, **161** and return modules **112**, **162**.

In some embodiments, the roaming application **120** may be adapted to execute on the home device **100**, for example through operation of application modules **121**, optionally operating in conjunction with the operating system **110** and hardware **101**. Application modules **121** may include any of an infinite number of potential functions and features. Application modules **121** may for example implement a game, a browser, a downloadable "App" for a smart phone or other computing device, and/or a productivity application such as those included in the MICROSOFT OFFICE® productivity suite. These application types or any other application type may be implemented via application modules **121**. In the course of executing on the home device **100**, the application modules **121** may interact with other applications that execute on the home device **100**, with the operating system **110**, with hardware **101**, and/or with the user of the home device **100**, for example, by receiving inputs and commands via the home device UI **102**, and by producing output via a display, speakers, or other output device.

In some embodiments, the application **120** may be arranged to provide an interface for receiving roam commands from a user, operating system **110** or device hardware **101**. Roam commands may be processed by the roam manager **122**. The roam manager **122** may include modules configured to cause the roaming application **120** to roam between devices, such as, from the home device **100** to the target device **150**. Functions of the roam manager **122** may include, for example, enforcing policies that a target device **150** may be of at least one accepted target device type. The roaming application **120** may be configured to be compatible with one or more known device types. Compatible device types may be enumerated in a list that is accessible by the roam manager **122** as the roaming application executes on the home device **100**. The roam manager **122** may be configured to query a target device **150** for type information, prior to roaming to the target device **150**. If the target device type information matches a device type from the list, the roam manager **122** may be configured to proceed with the roam operation. If the target device type information does not match a device type from the list, the roam manager **122** may be configured to prevent the roam operation from occurring, for example by throwing an error that notifies the user of the home device **100** that the target device type is not supported by the roaming application **120**.

A roam operation performed by the roam manager **122** may, but need not, be performed during execution of the roaming application on the home device **100**. The roam manager **122** may comprise one or more modules configured to transfer roaming application information, such as for example state information, application code, and application license information to the target device **150**, and to cause the application **120** to execute on the target device **150** using the transferred application information. Similarly, the roam manager **122** may be configured to return the roaming application **120** from the target device **150** to the home device **100**, during execution of the roaming application **120** on the target device **150**, through transfer of roaming application information to the home device **100**. Roam managers are discussed in further detail with reference to FIG. **3** and FIG. **4**, below.

The roaming application **120** may further comprise one or more return modules **123** configured to automatically initiate the return of the roaming application **120** from the target device **150** to the home device **100** in response to a return event. A return event may be any event that the return module **123** is configured to respond to by initiating a return to the home device **100**. A return event may be generated by a return module **123**, detected by a return module **123**, and/or provided to and received by the return module **123**. Some examples of return events include a timer reaching a designated value, completion of a designated task, a return signal from the home device, and/or detection of a failure in the target device **150**. A return module **123** may for example include one or more detect/generate return event module(s) configured to initiate a timer when the roaming application **120** roams from the home device **100** to the target device **150**, to determine when a designated task is complete at the target device **150**, to receive return information in a return signal at the target device **150** from the home device **100**, and/or to detect a failure in the target device **150**, the failure comprising one or more of: absence in the target device **150** of one or more enumerated features, and/or a failure by the target device **150** to perform one or more instructions associated with the roaming application **120**. Example return modules are discussed in further detail with reference to FIG. **5** and FIG. **6**, below.

In some embodiments, a roaming application **120** may include a module configured to override the return of the roaming application **120** from the target device **150** to the home device **100**, in response to a user command. For example, the roaming application **120** may be configured to present a UI at a target device **150** display, notifying the user of the target device **150** that the roaming application **120** has experienced a return event and will return to the home device **100**. The displayed UI may include a selectable return override control, allowing the user to override the return, thereby allowing the roaming application **120** to continue executing at the target device **150**.

In some embodiments, a roaming application **120** may include a module configured to automatically initiate a roam by the roaming application **120** from the target device **150** to a server **170**, in response to a detected failure to return to the home device **100**. For example, prior to returning to the home device **100**, the roam manager **122** may be configured to determine if link **190** is available. If the link **190** is available, then the roam manager **122** may be configured to proceed with a return operation, returning the roaming application **120** to the home device **100**. If the link **190** is not available, then the roam manager **122** may be configured to determine if another communication link, e.g., link **171** is available, allowing to the roam manager **122** to roam to server **170** via the internet. If the link **171** is available, then the roam manager **122** may be configured to cause roaming application **120** to roam to server **170** in lieu of returning to the home device **100**. In some embodiments the application **120** may roam to the server **170** and continue executing on the server **170**, and in some embodiments the roam manager **122** may save application information to the server **170**, and then shut down and optionally self-destruct the application **120** at the target device **150**. In either case, the application information and/or application **120** itself may subsequently return to the home device **100** when the home device is able to establish a link **172** to the server **170**.

In some embodiments, the operating system **110** may include roam manager **111** and return module **112**, which may be configured to cooperatively interact with roam manager **122** within roaming application **120** and/or roam manager **161** within the target device **150** to control roam of the application **120** from the home device **100** to the target device **150**, and return of the roaming application **120** from the target device **150** to the home device **100**. In embodiments wherein the operating system **110** controls roam and return of the application **120**, the roaming application **120** and target device **150** may or may not also include roam managers **122**, **161** and return modules **123**, **162**, however some embodiments may include a roam manager **122**, **161** in at least one of the roaming application **120** and target device **150**.

A home device **100** may be configured to provide an execution environment for a roaming application **120** on behalf of an owner of the roaming application **120**. An owner of the roaming application **120** may be, for example, a person or company that owns, rents, leases, licenses, or otherwise controls the home device **100** and may be able to purchase, license, or otherwise acquire application software, such as the roaming application **120**, and cause the software to run on the home device **100**. The device **100** may be considered a "home device" because it provides a home-base for execution of the roaming application **120** on behalf of the user of the device **100**. The term "home device" is not intended to imply that the device necessarily operates within a household structure. Instead, the term "home device" is used because the device **100** provides a "home" or primary execution environment for the roaming application **120**. The home device **100** may be, for example a laptop or desktop computer, smart phone, or other computing device as discussed in connection with FIG. **2**, regardless of whether such device is designed for personal, home, business, educational, experimental or other use.

A home device **100** may comprise a processor **104**, a memory **105**, and/or an operating system **110** loadable into the memory **105** and configured to execute on the processor **104**. The operating system **110** may be configured to provide an execution environment for the roaming application **120**.

The operating system **110** may be configured to transfer the roaming application **120** from the home device **100** to a target device **150**, during execution of the roaming application **120** at the home device **100** and in response to a user command received at the home device **100**, the transfer comprising transfer of roaming application information, such as state information and roaming application executable code from the home device to the target device. A user command received at the home device **100** may comprise for example a command received via a UI provided by the roaming application **120**, and/or a command received via a UI provided by the operating system **110**. The user command may indicate a desired target device **150** along with a command to roam to the target device **150**.

The operating system **110** may be configured to initiate return of the roaming application **120** from the target device **150** to the home device **100**, by sending a communication to the target device **150** in response to a return event. The return event received or generated by operating system **110** may comprise, for example, one or more of a user command, a timer reaching a designated value, and/or an interruption or degradation of signal quality on a communication channel **190** used by the home device **100** to communicate with the target device **150**.

In some embodiments, a communication from the operating system **110** to the target device **150** may comprise a message, such as one or more IP packets including message data in packet payload(s). In some embodiments, an operating system **110** communication to the target device **150** may comprise a Remote Procedure Call (RPC) to a target device **150** interface, such as an interface provided by communication device **153** and/or operating system **160**.

In some embodiments, the communication to the target device **150** may be configured for processing by the target device **150**. The communication may instruct the target device operating system **160** to return the roaming application **120** to the home device **100**. The target device operating system **160** can be configured to manage the return of the roaming application **120** to the home device **100**, in response to the communication from the home device operating system **110**. When the target device operating system **160** is configured to return the roaming application **120** to the home device **100**, the communication need not necessarily be passed to the roaming application **120**.

In some embodiments, the communication to the target device **150** may be configured for processing by the roaming application **120**. The communication to the target device **150** may include an instruction to the roaming application **120** to return to the home device **100**. The target device **150** may be configured to pass the communication to the roaming application **120**, and the roaming application **120** may be configured to respond to the communication by initiating return to the home device **100**.

In some embodiments, the operating system **110** may comprise instructions to retrieve the roaming application **120** from a server **170**, in response to a failure of the roaming application **120** to return to the home device **100**.

A target device **150** may be configured to provide an execution environment for a roaming application **120**, and configured to return the roaming application **120** to a home device **100** associated with an owner of the roaming application **120**. The target device **150** may comprise a processor **154**, a memory **155**, and/or an operating system **160** loadable into the memory **155** and configured to execute on the processor **154**.

The operating system **160** may be configured to provide an execution environment for the roaming application **120**, and the operating system **160** may be configured to transfer the roaming application **120** from the target device **150** to the home device **100**, optionally during execution of the roaming application **120**. As with the initial transfer to the target device **150**, the transfer from the target device **150** to the home device **100** may comprise transfer of roaming application information, such as state information and roaming application executable code to the home device **100**.

In some embodiments, the operating system **160** may be configured to initiate return of the roaming application **120** from the target device **150** to the home device **100** in response to a return event. The return event may comprise for example one or more of an automatically initiated return command from the roaming application **120**, a timer reaching a designated value, an interruption or degradation of signal quality on a communication channel **190** used by the home device **100** to communicate with the target device **150**, completion of a designated task, a return signal from the home device **100**, and/or a detected failure in the target device **150**. A target device **150** may be configured with an interface accessible via the communications device **153**, where the interface is configured to process received instructions to return the roaming application **120** to the home device **100**.

In some embodiments, the operating system **160** may comprise instructions to automatically transfer the roaming application **120** from the target device **150** to a server **170**, in response to a failure to return the roaming application **120** to the home device **100**.

FIG. **2** is a block diagram of a computing device **200** as one example of a home device **100** and/or target device **150**, arranged in accordance with at least some embodiments of the present disclosure. In a very basic configuration **201**, computing device **200** may include one or more processors **210** and system memory **220**. A memory bus **230** may be used for communicating between the processor **210** and the system memory **220**.

Depending on the desired configuration, processor **210** may be of any type including but not limited to a microprocessor (μP), a microcontroller (μC), a digital signal processor (DSP), or any combination thereof. Processor **210** may include one or more levels of caching, such as a level one cache **211** and a level two cache **212**, a processor core **213**, and registers **214**. The processor core **213** may include an arithmetic logic unit (ALU), a floating point unit (FPU), a digital signal processing core (DSP Core), or any combination thereof. A memory controller **215** may also be used with the processor **210**, or in some implementations the memory controller **215** may be an internal part of the processor **210**.

Depending on the desired configuration, the system memory **220** may be of any type including but not limited to volatile memory (such as RAM), non-volatile memory (such as ROM, flash memory, etc.), or any combination thereof. System memory **220** typically includes an operating system **221**, one or more applications **222**, and program data **225**. Operating system **221** may include, for example, one or more roam manager module(s) **221**A and return module(s) **221**B. The module(s) **221**A and **221**B may be configured to serve as home device modules such as **111** and **112**, as discussed with reference to FIG. **1**, and/or as target device modules such as **161** and **162**, as discussed with reference to FIG. **1**.

Applications **222** may include, for example, one or more roaming applications comprising roam manager module(s) **122** and return module(s) **123** as illustrated in FIG. **1**. Program data **225** may include roam data **226** and return data **227** that may be used by modules **221**A, **221**B, **122**, and/or **123**. It will be appreciated with the benefit of this disclosure that the features of the home device and target device operating systems, roaming application, roam managers and return modules disclosed herein may be rearranged and combined in a large variety of different ways. This disclosure contemplates the possibility of moving any of the disclosed features into any of described software elements, as may be necessary or convenient for particular embodiments.

Computing device **200** may have additional features or functionality, and additional interfaces to facilitate communications between the basic configuration **201** and any required devices and interfaces. For example, a bus/interface controller **240** may be used to facilitate communications between the basic configuration **201** and one or more data storage devices **250** via a storage interface bus **241**. The data storage devices **250** may be removable storage devices **251**, non-removable storage devices **252**, or a combination thereof. Examples of removable storage and non-removable storage devices include magnetic disk devices such as flexible disk drives and hard-disk drives (HDD), optical disk drives such as compact disk (CD) drives or digital versatile disk (DVD) drives, solid state drives (SSD), and tape drives, to name a few. Example computer storage media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data.

System memory **220**, removable storage **251**, and non-removable storage **252** are all examples of computer storage media. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium that may be used to store the desired information and that may be accessed by computing device **200**. Any such computer storage media may be part of computing device **200**.

Computing device **200** may also include an interface bus **242** for facilitating communication from various interface devices (e.g., output interfaces, peripheral interfaces, and communication interfaces) to the basic configuration **201** via the bus/interface controller **240**. Example output devices **260** include a graphics processing unit **261** and an audio processing unit **262**, which may be configured to communicate to various external devices such as a display or speakers via one or more A/V ports **263**. Example peripheral interfaces **270** may include a serial interface controller **271** or a parallel interface controller **272**, which may be configured to communicate through either wired or wireless connections with external devices such as input devices (e.g., keyboard, mouse, pen, voice input device, touch input device, etc.) or other peripheral devices (e.g., printer, scanner, etc.) via one or more I/O ports **273**. Other conventional I/O devices may be connected as well such as a mouse, keyboard, and so forth. An example communications device **280** includes a network controller **281**, which may be arranged to facilitate communications with one or more other computing devices **290** over a network communication via one or more communication ports **282**.

The computer storage media may be one example of a communication media. Communication media may typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and include any information delivery media. A "modulated data signal" may be a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media may include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), infrared (IR), and other wireless media.

Computing device **200** may be implemented as any device type, including for example, a smart phone, a laptop or desktop computer, a server computer, a tabletop or other display, a television, a stereo system, an on-board vehicle computer, a thermostat, a building security system, a building automation system, an appliance such as a refrigerator, coffee maker, microwave, and/or stovetop, a small-form factor portable (or mobile) electronic device such as a cell phone, personal data assistant (PDA), personal media player device, wireless webwatch device, and/or personal headset device, an application-specific device, and/or or a hybrid device that may include any of the above functions.

FIG. **3** is a block diagram illustrating an example roam manager, arranged in accordance with at least some embodiments of the present disclosure. The example roam manager **360** may include one or more operations/modules as illustrated by blocks **361**-**367**, which represent operations as may be performed in a method, functional modules in a device **200**, and/or instructions as may be recorded on a computer readable medium **350**. The illustrated blocks **361**-**367** may be arranged to provide functional operations including one or more of "Home Device Identification" at block **361**, "Suspend Application" at block **362**, "Acquire Application Information" at block **363**, and/or "Transmit Application Information" at block **367**. Block **363** may include "Acquire Application Code" at block **364**, "Acquire Application State" at block **365**, and/or "Acquire Application License" at block **366**.

In FIG. **3**, blocks **361**-**367** are illustrated as being performed sequentially, with block **361** first and block **367** last. It will be appreciated that blocks **361**-**367** may be re-ordered as convenient to suit particular embodiments, and that these blocks or portions thereof may be performed concurrently in some embodiments. It will also be appreciated that in some examples various blocks may be eliminated, divided into additional blocks, and/or combined with other blocks.

The example roam manager **360** may correspond to a roam manager within a roaming application **120**, such as roam manager **122**, or a roam manager such as **111**, **161**, and/or **221**A. In general, a roam manager **360** may oversee roaming operations, whether a roaming application **120** is roaming from a home device **100** to a target device **150**, between different target devices, from a target device **150** to a server **170**, from a server **170** to a home device **100**, and/or from a target device **150** to a home device **100**.

In a "Home Device Identification" block **361**, the roam manager **360** may be configured to identify a home device. The roam manager **360** may be configured to query the home device **100** and/or operating system **110** for a home device identifier, and may be configured to store the returned home device identifier. Any identifier may be used, for example, an Internet Protocol (IP) address, a Global Unique Identifier (GUID) for the home device **100** and/or operating system **110**, and/or a user-assigned identifier. The roam manager **360** may be configured to subsequently use the home device identifier in situations wherein the roaming application **120** attempts to return from a target device **150** to the home device **100**, as discussed in further detail herein. Block **361** may be followed by block **362**.

In a "Suspend Application" block **362**, the roam manager **360** may be configured to suspend further execution of the roaming application **120** in preparation for roaming from a host device, which provides a present execution environment for the roaming application **120**, to a roam target, which provides a desired next execution environment for the roaming application **120**. In some embodiments, suspending a roaming application may comprise pausing the application, without fully closing or exiting from the application. In some embodiments, suspending a roaming application may comprise fully stopping the application. In some embodiments, suspending a roaming application may comprise stopping the roaming application in addition to disabling the application from further execution at the host device. For example, an application license key may be made unavailable or inoperable.

Depending on the circumstances of where a roaming application **120** is presently executing, a home device **100** may be a host device or a roam target, and a target device **150** may also be a host device or a roam target. The roam manager **360** may be configured to suspend the roaming application **120** on the host device, for example, in response to a UI command to roam to a roam target. The roam manager **360** may be configured to suspend the roaming application by inserting a suspend command in the execution path of the roaming application **120**, and/or through a request to a host device operating system. Block **362** may be followed by block **363**.

In a "Acquire Application Information" block **363**, any information needed to allow the application **120** to roam to a roam target, resume executing at the roam target, and return to the home device, if applicable, may be gathered and stored into a data structure for transmission to the roam target. Examples of acquiring application information **363** include acquiring application code **364**, acquiring application state **365**, and acquiring application license **366**. Block **363** may include blocks **364**, **365**, and **366**.

In a "Acquire Application Code" block **364**, the roam manager **360** may be configured to load application code into a data structure, such as a code file in active device memory. Application code may include computer readable instructions and data structures corresponding to the roaming application **120**, including for example one or more of code that is in an execution path of a host device processor, code loaded into a host device memory, and/or application code stored on a disk or other non-volatile memory accessible by the host device. In some embodiments, when the host device is any device other than the home device **100**, the roam manager **360** may be configured to delete any application code for the roaming application **120** that is not stored in the code file(s) in preparation for roaming. Block **364** may be followed by block **365**.

In a "Acquire Application State" block **365**, the roam manager **360** may be configured to store application state information in a data structure, such as a roaming application state file in active device memory of a host device. Application state information may comprise any information allowing the roaming application **120** to enter a same or substantially similar state, after arriving at a roam target, as the state of the application in the host device at the time the application was paused. For example, any active UI, session history, open files, and queued operations may be stored as application state information. Block **365** may be followed by block **366**.

In a "Acquire Application License" block **366**, the roam manager **360** may be configured to store application license information in a data structure, such as a roaming application license file in active device memory of a host device. The license may comprise a license or license key granting the roam target any desired level of application use rights. The roam target may be provided with a full license or limited license. Limited licenses may limit roaming application functions and/or application usage intervals. Block **366** may be followed by block **367**.

In a "Transmit Application Information" block **367**, the roam manager **360** may be configured to initiate transmission of application state file(s) and/or other data structures and code file(s) and/or other data structures from the host device to the roam target. The roam manager **360** may be configured to command host device hardware and/or a host device operating system or subcomponents thereof to transmit the application state file(s) and code file(s) to an identified roam target. In the case of a roam that is initiated by a user, the roam manager **360** may be configured to receive roam target identification information for example via a UI interaction with a user. In the case of a roam that is initiated by a return module, the roam manager **360** may be configured to receive roam target identification information for example from the return module.

FIG. **4** is a schematic diagram illustrating example operations of a roam manager **360**, arranged in accordance with at least some embodiments of the present disclosure. FIG. **4** includes a roam manager **360** comprising blocks **361-367** as illustrated in FIG. **3**. Additionally, FIG. **4** provides an operating system **400**, memory **410**, disk **420**, and application modules **121**.

In FIG. **4**, a Home Device ID **456** is illustrated as passing from the OS **400** to the "Home Device Identification" block **361**. A Suspend Instruction **455** is illustrated as passing from the "Suspend Application" block **362** to one or more of the OS **400** and/or the application modules **121**. An "Acquire Application Information" block **363** includes a variety of example blocks **364-366** configured to acquire application information as discussed in connection with FIG. **3**. State information **454** is illustrated as passing between the "Acquire Application State" block **365** and memory **410**, via OS **400**. State information **454** may be stored in one or more application information file(s) in memory **410**. Code **453** is illustrated as passing between the "Acquire Application Code" block **364** and memory **410**, via OS **400**. Code **452** is illustrated as passing from disk **420** to the "Acquire Application Code" block **364**, and from the "Acquire Application Code" block **364** to memory **410**, via OS **400**. Code **452** and **453** may be stored in one or more application information file(s) in memory **410**. License information **457** is illustrated as passing between the "Acquire Application License" block **366** and memory **410**, via OS **400**. License information **457** may also be stored in one or more application information file(s) in memory **410**. Transmission Instructions **451** are illustrated as passing from the "Transmit Application Information" block **367** to the OS **400**.

Much of FIG. **4** may be understood by reference to the various blocks described with reference to FIG. **3**. It should be noted that the roam manager **360** may in some embodiments be included in a roaming application **120** along with application modules **121**, and may in some embodiments be included in operating system **400**.

In FIG. **4**, memory **410** may initially include application state information **454**. After suspending the application modules **121**, the "Acquire Application State" block **365** may be configured to gather and consolidate the state information **454** in one or more application state file(s), which may be stored back in the memory **410** in one or more application information file(s) for transmission pursuant to a roam operation. Similarly, memory **410** may include code **453** as well as other application data and application license information **457**, while disk **420** may include additional code **452**, application data, and optionally application license information **457** as well. The "Acquire Application Code" block **364** may gather and consolidate the code **452**, **453** and application data in one or more code file(s), which may be stored back in the memory **410** in one or more application information file(s) for transmission pursuant to a roam operation. The "Acquire Application License" block **366** may gather and/or generate a roam license **457** from memory **410** or disk **420** (gathering from disk not shown) for use at the roam target, and may store license information in the memory **410** in one or more application information file(s) for transmission pursuant to a roam operation. Transmission instructions **451** may indicate a roam target to the operating system **400**, so that the application information file(s) in memory **410** may be transmitted to the roam target. The roam manager **360** may also be configured to launch the roaming application **120** upon arrival of the application information file(s) at the roam target.

FIG. **5** is a block diagram illustrating an example return module, arranged in accordance with at least some embodiments of the present disclosure. The example return module may include one or more operations/modules as illustrated by blocks **511-512**, which represent operations as may be performed in a method, functional modules in a device **200**, and/or instructions as may be recorded on a computer readable medium **550**. The illustrated blocks **511-512** may be arranged to provide functional operations including one or more of "Detect/Generate Return Event" at block **511**, and/or "Initiate Return" at block **512**.

In FIG. **5**, blocks **511-512** are illustrated as being performed sequentially, with block **511** first and block **512** last. It will be appreciated that blocks **511-512** may be re-ordered as convenient to suit particular embodiments, and that these blocks or portions thereof may be performed concurrently in some embodiments. It will also be appreciated that in some examples various blocks may be eliminated, divided into additional blocks, and/or combined with other blocks.

The example return module **510** may correspond to a return module within a roaming application, such as return module **123**, or a return module such as **112**, **162**, and/or **221**B. In general, a return module **510** may initiate a return of a roaming application to a home device. The return module **510** may initiate such return in response to a return event. The return module **510** may be configured according to whether it is incorporated into a roaming application, such as return module **123** in FIG. **1**, whether it is incorporated into a home device operating system **110** such as return module **112** in FIG. **1**, or whether it is incorporated into a target device operating system **160** such as return module **112** in FIG. **1**.

In some embodiments, return module **510** may be configured to load after a roam operation. When a return module **510** incorporated into a roaming application, such as return module **123** in FIG. **1**, the return module **510** may be configured to first determine whether the host device is also the home device **100**, for example by checking the home device identifier. If the host device is also the home device **100**, the return module **510** may be configured to exit, it is not needed. If the host device is a target device **150**, the return module **510** may be configured to load the "Detect/Generate Return Event" module **511**.

In a "Detect/Generate Return Event" block **511**, return module **510** may be configured to detect and/or generate a return event. When a return module **510** incorporated into a roaming application, such as return module **123** in FIG. **1**, a return module **510** may be configured to detect and/or generate a return event for example by checking one or more parameters of a target device **150** as the roaming application **120** executes thereon, by receiving a return event, such as by receiving a notification from an application module **121** or target device operating system **160**, and/or by generating a return event, for example by setting a timer, wherein the timer reaching a predefined value is defined as a return event. In this regard, return module **510** may include for example, a module configured to initiate a timer when the roaming application **120** roams from the home device **100** to the target device **150**, a module configured to determine when a designated task is complete at the target device **150**, a module configured to receive return information in a return signal at the target device **150** from the home device **100**, and a module configured to detect a failure in the target device **150**, the failure comprising one or more of: absence in the target device **150** of one or more enumerated features, and/or a failure by the target device **150** to perform one or more instructions associated with the roaming application **120**.

In some embodiments, a module configured to determine when a designated task is complete at the target device **150** may for example be configured to receive a return event from an application module **121**, when the application module completes a task. The return module **510** may be configured to initiate return of the roaming application **120** to the home device **100** after completion of a task.

In some embodiments, a module configured to receive return information in a return signal at the target device **150** from the home device **100** may for example be configured to receive a return information generated by the home device **100**, and sent to the target device **150**, where the return information is then passed to the return module **510**. The return instructions may for example indicate a user command to return, a user command not to return, and/or a user command to roam to a different target device.

In some embodiments, a module configured to detect a failure in the target device **150** may for example be configured to receive a failure notification from an application module **121**, when the application module **121** fails to complete a task. The failure may comprise, for example, one or more of absence in the target device **150** of one or more enumerated features and/or a failure by the target device **150** to perform one or more instructions associated with the roaming application **120**. The return module **510** may be configured to initiate return of the roaming application **120** to the home device **100** when it is discovered that the target device **150** may not be capable of completing desired tasks.

In embodiments in which the return module **510** is incorporated into a home device operating system **110** and/or target device operating system **160**, the return module **510** may be configured to load the "Detect/Generate Return Event" module **511** when a roaming application **120** roams from home device **100** to the target device **150**. The "Detect/Generate Return Event" block **511** may be followed by the "Initiate Return" block **512**, in which the return module **510** is configured to initiate return of the roaming application **120** to the home device **100**, for example by commanding a roam manager to return the roaming application **120** to the home device **100**.

In embodiments in which the return module **510** is incorporated into a home device operating system **110**, a return module **510** may be configured to detect and/or generate a return event for example by receiving a user command, a timer reaching a designated value, and/or an interruption or degradation of signal quality on a communication channel used by the home device to communicate with the target device.

In some embodiments, a user command may comprise a command received via an operating system **110** user interface feature configured to initiate return of the roaming application **120** from the target device **150**. For example, the user of a home device may initially cause a roaming application **120** to roam to a desired target device **150**. The user may subsequently recall the roaming application **120** from the target device **150**, using the UI available to the user at the home device **100**. The home device operating system **110** may provide UI configured to allow the user to recall the roaming application **120**. The UI may be configured to produce a user-generated return event that is passed to the return module **510**. The return module **510** may be configured to send return information to the target device **150**, instructing the target device operating system **160** and/or roaming application **120** to return to the home device **100**.

In embodiments in which the return module **510** is incorporated into a home device operating system **110**, a timer may comprise a timer initiated by the operating system **110** when the roaming application **120** roams away from the home device **100**. The return module **510** may be configured to generate a return event when the timer reaches a predetermined value. The return module **510** may be configured to initiate return by sending return information to the target device **150**, instructing the target device operating system **160** and/or roaming application **120** to return to the home device **100**.

In embodiments in which the return module **510** is incorporated into a home device operating system **110**, the interruption or degradation of communication channel signal quality may comprise a degradation of communication channel signal quality due to a wireless range between the home device **100** and the target device **150**. The return module **510** may be configured to monitor signal quality of link **190**. The return module **510** may be configured to initiate return in response to signal quality dropping below a predetermined signal strength. As with the above-described return events, the return module **510** may be configured to initiate return by sending return information to the target device **150**, instructing the target device operating system **160** and/or roaming application **120** to return to the home device **100**.

In embodiments in which the return module **510** is incorporated into a target device operating system **160**, a return module **510** may be configured to detect and/or generate a return event for example by receiving an automatically initiated return command from the roaming application **120**, a timer reaching a designated value, detecting an interruption or degradation of signal quality on a communication channel used by the home device to communicate with the target device, detecting completion of a designated task, receiving a return signal from the home device, and/or detecting a failure in the target device. The various operations involved are described herein with respect to return modules incorporated into a roaming application **120** and home device operating system **110**. It will be understood that corresponding structures and methods may be included in a target device operating system **160**.

In some embodiments, it should be noted that a return module **510** may be configured to cause a roaming application to roam to a device other than the home device **100**. For example, the home device **100** may instruct the return module **510** to cause the roaming application to roam from a first target device to a second target device. The return module may pass this information to the roam manager, and initiate a roam operation, causing the roaming application to roam to the second target device.

FIG. **6** is a schematic diagram illustrating example operations of a return module **510**, arranged in accordance with at least some embodiments of the present disclosure. FIG. **6** includes a return module **510** comprising blocks **511**-**512** as illustrated in FIG. **5**. Additionally, FIG. **6** provides application modules **121**, OS 400, and roam manager **360**.

In FIG. **6**, a return event **571** is illustrated as passing from the application modules **121** to the return module **510**. A return event **571** is illustrated as also passing from the OS 400 to the return module **510**. An initiate instruction **572** is illustrated as passing from the return module **510** to the roam manager **360**.

Much of FIG. **6** may be understood by reference to the various blocks described with reference to FIG. **5**. FIG. **6** is included herein to depict the return module **510** receiving return events **571** from application modules **121** and/or an operating system **400**. The return module **510** may also generate a return event using the detect/generate return event module **511** as discussed herein. Upon detecting and/or generating a return event, the initiate return module **512** may send initiate instruction **572** to the roam manager **360**. The initiate instruction may comprise in instruction to roam to a roam target, and an identifier for the roam target. In some embodiments, the roam target may comprise the home device **100** identified by the home device identifier discussed herein. In some embodiments, the return module **510**, roaming application **120**, and/or or operating systems **110**, **160**, may also comprise instructions configured to launch the return module **510** and/or aspects thereof when a roaming application engages in a roaming operation.

FIG. **7**, including FIG. **7**A and FIG. **7**B, is a diagram illustrating example operations and interactions of a user, roaming application, roam manager(s), and return module(s) as they interact with a home device and target device. FIG. **7** includes a line representing a user **700**, a roaming application **120** as it executes at a home device **100**, a roam manager **122** or **111** as it executes at a home device **100**, a return module **123** or **112** as it executes at a home device **100**, a roaming application **120** as it executes at a target device **150**, a roam manager **122** or **161** as it executes at a target device **150**, and a return module **123** or **162** as it executes at a target device **150**. Operations of each of the above are illustrated through a time interval including a roam from the home device **100** to a target device **150**, and a return from the target device **150** to the home device **100**.

With reference to FIG. 7A, user **700** may activate the roaming application **120** at a home device **100** in operation **701**. For example, the user **700** may provide an activate command **771** to the roaming application **120** via a home device UI **102** and/or home device operating system **110**. The roaming application **120** may be configured to respond to the activate command **771** by activating roaming application modules in operation **711**.

The roaming application **120** may be configured to execute at the home device **100**, performing application functions and interacting with the user **700** pursuant to the features and functions for which the application **120** and modules thereof are designed. In some embodiments, the roaming application **120** may be configured to perform operation **712** to issue an activate command **772** to activate a roam manager **122** at the home device **100**. In some embodiments, a roam manager **111** may be a part of the home device OS, and the home device OS may be configured to activate roam manager **111**.

The user may perform operation **702** to provide a roam command **773** to the roam manager **122** or **111**. The roam command **773** may be provided to the roam manager **122** or **111** via a home device OS UI, home device hardware UI, and/or roaming application UI. In response to the roam command **773**, the roam manager **122** or **111** may be configured to suspend the roaming application in operation **721**, for example by issuing suspend command **774** to the roaming application **120**. Suspend commands such as **774** may also be provided via a home device OS or home device hardware instructions. The roam manager **122** or **111** may also be configured to acquire application information **1** in operation **723**. Application information **1** may comprise, for example, roaming application state information, data, code, and/or license information as described herein, as acquired at the home device **100**. The roam manager **122** or **111** may be configured to transmit application information **1** in operation **724**, for example by sending roaming application information **1 775** to the target device **150**.

The target device OS and/or roaming application **120** may be configured to activate the roaming application modules at the target device **150** in operation **741**. The roaming application **120** may be configured to execute at the target device **150**, performing application functions and interacting with the user **700** pursuant to the features and functions for which the application **120** and modules thereof are designed. In some embodiments, the roaming application **120** may be configured to perform operation **742** to issue an activate command **778** to activate a roam manager **122** at the target device **150**. In some embodiments, a roam manager **161** may be a part of the target device OS, and may be activated by the target device OS. The roam manager **122** or **161** may be configured to activate a return module **123** or **162** at the target device **150** in operation **751**, which may for example send activate command **779** to the return module **123** or **162**.

The roam manager **122** or **111** at the home device **100** may optionally also be configured to activate a return module **112** at the home device **100**, in operation **725**, for example by sending activate command **776** to the return module **112**. In such embodiments, the return module **112** at the home device **100** may optionally be configured to detect and/or generate a return event at operation **731**, while the roaming application **120** executes at the target device **150**. For example, a user may provide a return command **703** to the home device, which may issue return command **777** to the return module **112** at the home device **100**. In response to return command **777**, the return module **112** at the home device **100** may be configured to initiate return of the roaming application in operation **732**, by providing an initiate return instruction **780** to the roam manager **111**. Turning to FIG. 7B, the roam manager **111** may be configured to respond to the initiate return instruction **780** by performing a transmit return event operation **726**, transmitting return command **781** to the return module **123** or **162** at the target device **150**.

The return module **123** or **162** at the target device **150** may be configured to detect and/or generate a return event in operation **761**. In some embodiments, the return event may comprise return command **781** received from the home device **100**. However, the return event that is generated and/or detected in operation **761** may comprise any number of other return events, examples of which are described herein. In response to the generated and/or detected return event, the return module **123** or **162** at the target device **150** may be configured to initiate return of the roaming application in operation **762**, for example by sending an initiate return instruction **782** to the roam manager **122** or **161** at the target device **150**.

The roam manager **122** or **161** at the target device **150** may be configured to respond to the initiate return instruction **782** by suspending the roaming application in operation **752**, for example by issuing a suspend command **783** to the roaming application **120** executing at the target device **150**. Suspend commands such as **783** may also be provided via a target device OS or target device hardware instructions. The roam manager **122** or **161** may also be configured to acquire application information **2** in operation **754**. Application information **2** may comprise, for example, roaming application state information, data, code, and/or license information as described herein, as acquired at the target device **150**. The roam manager **122** or **161** may be configured to transmit application information **2** in operation **755**, for example by sending roaming application information **2** **784** to the home device **100**.

The home device OS and/or roaming application **120** may be configured to activate the roaming application modules at the home device **100** in operation **713**. The roaming application **120** may execute at the home device **100**, performing application functions and interacting with the user **700** pursuant to the features and functions for which the application **120** and modules thereof are designed.

There is little distinction left between hardware and software implementations of aspects of systems; the use of hardware or software is generally (but not always, in that in certain contexts the choice between hardware and software may become significant) a design choice representing cost vs. efficiency tradeoffs. There are various vehicles by which processes and/or systems and/or other technologies described herein may be effected (e.g., hardware, software, and/or firmware), and that the preferred vehicle will vary with the context in which the processes and/or systems and/or other technologies are deployed. For example, if an implementer determines that speed and accuracy are paramount, the implementer may opt for a mainly hardware and/or firmware vehicle; if flexibility is paramount, the implementer may opt for a mainly software implementation; or, yet again alternatively, the implementer may opt for some combination of hardware, software, and/or firmware.

The foregoing detailed description has set forth various embodiments of the devices and/or processes via the use of block diagrams, flowcharts, and/or examples. Insofar as such block diagrams, flowcharts, and/or examples contain one or more functions and/or operations, it will be understood by those within the art that each function and/or operation within such block diagrams, flowcharts, or examples may be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one embodiment, several portions of the subject matter described herein may be implemented via Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), digital signal processors (DSPs), or other integrated formats. However, those skilled in the art will recognize that some aspects of the embodiments disclosed herein, in whole or in part, may be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more processors (e.g., as one or more programs running on one or more microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and/or firmware would be well within the skill of one of skill in the art in light of this disclosure. In addition, those skilled in the art will appreciate that the mechanisms of the subject matter described herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive, a Compact Disc (CD), a Digital Video Disk (DVD), a digital tape, a computer memory, etc.; and a transmission type medium such as a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.).

Those skilled in the art will recognize that it is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to integrate such described devices and/or processes into data processing systems. That is, at least a portion of the devices and/or processes described herein may be integrated into a data processing system via a reasonable amount of experimentation. Those having skill in the art will recognize that a typical data processing system generally includes one or more of a system unit housing, a video display device, a memory such as volatile and non-volatile memory, processors such as microprocessors and digital signal processors, computational entities such as operating systems, drivers, graphical user interfaces, and applications programs, one or more interaction devices, such as a touch pad or screen, and/or control systems including feedback loops and control motors (e.g., feedback for sensing position and/or velocity; control motors for moving and/or adjusting components and/or quantities). A typical data processing system may be implemented utilizing any suitable commercially available components, such as those typically found in data computing/communication and/or network computing/communication systems. The herein described subject matter sometimes illustrates different components contained within, or connected with, different other components. It is to be understood that such depicted architectures are merely examples, and that in fact many other architectures may be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality may be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermediate components. Likewise, any two components so associated may also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated may also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically connectable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art may translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to inventions containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

While certain example techniques have been described and shown herein using various methods, devices and systems, it should be understood by those skilled in the art that various other modifications may be made, and equivalents may be substituted, without departing from claimed subject matter. Additionally, many modifications may be made to adapt a particular situation to the teachings of claimed subject matter without departing from the central concept described herein. Therefore, it is intended that claimed subject matter not be limited to the particular examples disclosed, but that such claimed subject matter also may include all implementations falling within the scope of the appended claims, and equivalents thereof.

The invention claimed is:

1. A non-transitory computer readable medium having computer executable instructions configured to automatically initiate a return of a roaming application from a target device to a home device, wherein the home device provides an execution environment for the roaming application on behalf of an owner of the roaming application, wherein the instructions comprise:

one or more roaming application modules configured to execute on the home device;

one or more roam manager modules configured to manage a roam of the roaming application from the home device to a target device of at least one target device type, through transfer of one or more of roaming application state information and roaming application executable code to the target device;

wherein the one or more roaming application modules are configured to execute on the target device of at least one target device type, using one or more of the roaming application executable code and application state information received at the target device from the home device;

wherein the roam manager modules are configured to manage a return of the roaming application from the target device to the home device, through transfer of one or more of roaming application state information and roaming application executable code to the home device;

one or more return modules configured to automatically initiate the return of the roaming application from the target device to the home device, through transfer of one or more of roaming application state information and roaming application executable code from the target device to the home device, in response to a return event, the return event comprising one or more of:

detection of a return signal from the home device; and/or

detection of a failure at the target device; and

at least one module configured to:

determine whether a communication link between the target device and the home device is available, wherein:

when the communication link is available, the roam manager modules may proceed to manage the return of the roaming application from the target device to the home device in response to the return event; and

when the communication link is not available, the at least one module is configured to determine whether a communication link between the target device and a server is available; and

automatically initiate a roam by the roaming application from the target device to the server, instead of the return of the roaming application from the target device to the home device, when the communication link between the target device and the home device is not available and the communication link between the target device and the server is available.

2. The non-transitory computer readable medium of claim **1**, wherein the one or more return modules are configured to automatically initiate the return of the roaming application from the target device to the home device, through transfer of one or more of roaming application state information and roaming application executable code from the target device to the home device, in response to a return event comprising completion of a designated task at the target device, wherein the return event is provided by the one or more roaming application modules to the one or more return modules in order for the one or more return modules to determine when the designated task is complete.

3. The non-transitory computer readable medium of claim **1**, wherein the instructions comprise a module configured to receive return information in the return signal from the home device, the return information comprising a user command generated at the home device.

4. The non-transitory computer readable medium of claim **1**, wherein the instructions comprise a module configured to detect the failure at the target device during execution of the one or more roaming application modules at the target device, and to automatically initiate the return of the roaming application from the target device to the home device responsive to detection of the failure, the failure comprising one or more of: absence of one or more enumerated features at the target device, and/or a failure to perform one or more instructions associated with the roaming application at the target device.

5. The non-transitory computer readable medium of claim **1**, wherein the instructions comprise a module configured to override the return of the roaming application from the target device to the home device, in response to a user command, wherein the module configured to override the return of the roaming application from the target device to the home device is configured to present a User Interface (UI) at the target device, wherein the UI notifies a user at the target device of the return event, and wherein the UI includes a user selectable return override control to allow the one or more roaming application modules to continue executing at the target device.

6. A home device configured to provide an execution environment for a roaming application on behalf of an owner of the roaming application, the home device comprising:

a processor;

a memory;

an operating system loadable into the memory and configured to execute on the processor, wherein the operating system is configured to:

manage an execution environment for the roaming application;

transfer the roaming application from the home device to a target device in response to a user command received at the home device, the transfer comprising:

transfer of one or more of roaming application state information and roaming application executable code from the home device to the target device; and

wherein the target device and the home device are separate devices, each comprising its own respective processor and memory, and wherein the target device and the home device communicate via a communication link between the target device and the home device, at least a portion of which communication link is external to the target device and the home device;

wherein the operating system is configured to initiate return of the roaming application from the target device to the home device, through transfer of one or more of roaming application state information and roaming application executable code from the target device to the home device, by initiating a communication to the target device in response to a return event, the return event comprising one or more of:

detection of a user initiated command; and/or

an interruption or degradation of signal quality on the communication link between the target device and the home device; and

wherein the roaming application is configured to:

determine whether the communication link between the target device and the home device is available, wherein:

when the communication link is available, the roaming application may return from the target device to the home device in response to the return event; and

when the communication link is not available, the roaming application is configured to determine whether a communication link between the target device and a server is available; and

automatically roam from the target device to the server, instead of the home device, when the communication link between the target device and the home device is not available and the communication link between the target device and the server is available.

7. The home device of claim **6**, wherein the communication to the target device in response to the return event comprises a remote procedure call to a target device interface, the remote procedure call comprising an instruction to the roaming application to return to the home device.

8. The home device of claim **6**, wherein the operating system comprises a user interface feature configured to initiate return of the roaming application from the target device, and wherein the user command comprises a command received via the user interface feature.

9. The home device of claim **6**, wherein when the return event comprises the interruption or degradation of signal quality, the interruption or degradation of signal quality comprises a degradation of signal quality due to a wireless range between the home device and the target device.

10. The home device of claim **6**, wherein the operating system comprises instructions to retrieve the roaming application from the server, in response to a failure of the roaming application to return to the home device.

11. A target device configured to provide an execution environment for a roaming application, and configured to return the roaming application to a home device associated with an owner of the roaming application, the target device comprising:

a processor;

a memory;

an operating system loadable into the memory and configured to execute on the processor, wherein the operating system is configured to:

manage an execution environment for the roaming application;

transfer the roaming application from the target device to the home device, the transfer comprising:

transfer of one or more of roaming application state information and roaming application executable code to the home device; and

wherein the operating system is configured to initiate return of the roaming application from the target device to the home device, through transfer of one or more of roaming application state information and roaming application executable code from the target device to the home device, in response to a return event, the return event comprising one or more of:

an automatically initiated return command from the roaming application;

an interruption or degradation of signal quality on a communication link between the target device and the home device;

detection of a return signal from the home device; and/or

detection of a failure in the target device; and

wherein the operating system is configured to:

determine whether the communication link between the target device and the home device is available, wherein:

when the communication link is available, the roaming application may be returned from the target device to the home device in response to the return event; and

when the communication link is not available, the operating system is configured to determine whether a communication link between the target device and a server is available; and

automatically transfer the roaming application from the target device to the server, instead of the home device, when the communication link between the target device and the home device is not available and the communication link between the target device and the server is available.

12. The target device of claim **11**, further comprising an interface accessible via the communication link between the target device and the home device, wherein the interface is configured to process received instructions to return the roaming application to the home device.

13. The target device of claim **11**, wherein the operating system is configured to initiate return of the roaming application from the target device to the home device, through transfer of one or more of roaming application state information and roaming application executable code from the target device to the home device, in response to a return event comprising completion of a designated task by the target device on behalf of the roaming application.

14. The target device of claim **11**, wherein when the return event comprises the detection of the failure in the target device, the failure in the target device comprises a failure by the target device to perform one or more instructions associated with the roaming application.

15. The target device of claim **11**, wherein the automatically initiated return command from the roaming application comprises a command generated by the roaming application without interaction with the home device and without interaction with a user of the target device.

16. The target device of claim **11**, wherein when the return event comprises the interruption or degradation of signal quality, the interruption or degradation of signal quality comprises a degradation of signal quality due to a wireless range between the home device and the target device.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

Page 1 of 1

PATENT NO.	: 9,319,456 B2
APPLICATION NO.	: 13/816552
DATED	: April 19, 2016
INVENTOR(S)	: Gilder

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the specification,

In Column 1, Line 5, delete “APPLICATIONS APPLICATION” and insert -- APPLICATION --, therefor.

In Column 1, Line 8, delete “35U.S.C. §371of” and insert -- 35 U.S.C. § 371 of --, therefor.

Signed and Sealed this
Twenty-fifth Day of October, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office